Joint Centre for Mesoscale Meteorology, Reading, UK

Program for PV Inversion and Modification

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Introduction

The aim of this documentation is to help users to run the potential vorticity inversion program and associated programs. Guidance is outlined to describe and to use various programs for the potential vorticity (PV) inversion and modifications. Background on the data sources, model diagnostics (MDIAG) programs and the display system is highlighted in the first section. A brief summary of the basics of the main PV inversion program is given in the second section. Using the programs for simple PV inversion is described in the third section. If a user wants to modify PV distribution first and then make the PV inversion, the fourth section is dedicated for this purpose. After having the results of the programs, the next step is to display them. The fifth section provides information about displaying results on a pressure surface, on an isentopic surface or on a PV surface. The Appendices (A, B and C), give list of programs, detailed documents on the parameters list and a copy of a command file (MDPVINRE.COM).

1 Background on the Data Sources, Mdiag Programs, Display Systems and the PV Inversion Technique

The data used in our studies are taken from the UK Meteorological Office (hereafter UKMO) archived operational analyses and forecasts. The UKMO Unified Model (hereafter UM) is hydrostatic, and uses spherical polar coordinates. (For details see Cullen 1993.) The UKMO uses the same model for operational weather prediction in global (0.8333°x1.25° resolution, 19 levels), and regional, also known as the Limited Area Model (LAM), (0.442°x0.442°, 19 levels, 229x132 points, rotated pole at 30°N, 160°E) configurations.

The LAM data have a horizontal resolution of about 50-km, and a vertical resolution, above the boundary layer, of about 1-km. The LAM data used in our studies have been analyzed using a display system at the Joint Centre for Mesoscale Meteorology at Reading University (hereafter JCMM), called DISP. The DISP data are interpolated to

lower resolution with a horizontal resolution of about 100-km, and a vertical resolution of 100-mb. After interpolating these data onto the DISP levels, an extensive set of diagnostics are calculated.

Forecasts and analyses from the LAM have been used. Forecasts contain fields of forecast data at 3-hourly intervals from T+0 to T+48 (hours). Four forecast runs (the 0000 (hereafter FA), 0600 (hereafter FB), 1200 (hereafter FC), and 1800 (hereafter FD)) are available. Analyses are obtained every 6 hours, at 0000 UTC, 0600 UTC, 1200 UTC and 1800 UTC. The T+3 forecast fields are used as nominal intermediate analyses at the starting time of each forecast.

1.1 MDIAG PROGRAMS

MDIAG is a set of FORTRAN programs run to compute a variety of diagnostics using UM data on regular pressure levels (100-mb for the LAM). It uses the 6 basic fields of the UM - geopotential height, temperature, wind (u,v), specific humidity (q), and vertical velocity (w) - to calculate other parameters.

There are two versions of MDIAG available at the JCMM. In this report programs run on a VAX under the VMS operating system will be documented. (For the UNIX version see Panagi and Dicks 1997.)

The MDIAG program is made from 5 FORTRAN source modules. These are:
MDIAG: Defines parameters, scaling and ranges. It reads a catalogue file (.CAT in short) and a data file (.DAT in short) which contains basic parameters (wind, temperature, vertical velocity and humidity). The program then writes out data in .DB (which contains large data output) and .ATB (which contains catalogue) files.
MTHERMO: Performs basic thermodynamic calculations.
MDIAG_CALC: Calculates dynamical parameters.
MPACK: Routines to pack and unpack data.
MQSAT: Routines to return saturation mixing ratio over ice and over water. This is used for humidity conversion.
The operational programs are kept in USER1:[MD] directory.

1.2 DISPLAY PROGRAMS: MDIAG_LEVEL AND MDIAG_SURFACE

These programs create files that can be read by DISP (see section 1.3).

- MDIAG_LEVEL: Extracts a pressure level from a .DB dataset.
- MDIAG_SURFACE: Extracts parameters onto a surface. e.g. isentropic surface.

These programs are each linked with two other FORTRAN modules:

- MPACK: Routines to pack and unpack data.
- P_FORM: Routine to make P_FORMAT data. (The output data in a format packed that can be read by DISP.)

1.3 PC DISPLAY SYSTEM: DISP

DISP is a PC based graphics program widely used at JCMM. It can read, plot, and overplot model data, satellite and radar data. The model data have to be on a polar-stereographic grid and on a constant parameter surface. (For example data on a pressure level or an isentropic surface.) The DISP area covers mid and Eastern Atlantic and the western part of Europe at 61x38 resolution; grid spacing is about 100-km. Thus a low-resolution version of LAM fields is used at JCMM. In order to provide data in a special resolution and format, the above MDIAG_LEVEL and MDIAG_SURFACE programs are used.

2 PV Inversion Routine: MPVINVRE.FOR

By using the invertibility principle for PV, one can obtain the related rotational wind and temperature fields. We use non-linear balance PV inversion (Davis and Emanuel 1991, and Ziemianski 1994). Note that the inverted winds are the rotational component of the total wind field.

Some additions and modifications have been made to the original PV inversion program, particularly to increase convergence efficiency. (For details see Demirtaş 1996.) To obtain the most efficient convergence rate of the numerical solution it has been found

that the coefficient, COEF2=[(H/L)**2], must be chosen in a way that the equations used in the PV inversion technique obey the standard synoptic scaling,

i.e. $L \approx (N/f)H$

where $N/f \approx 100$ and $H \approx 10$ km. Here N is the Brunt-Väisällä frequency ($\approx 10^{-2} s^{-1}$), and f is the coriolis parameter ($\approx 10^{-4} s^{-1}$). Various L values (100-km < L < 1000-km) have been tested with the model. It was noted that sub-synoptic scales of L from 300-km to 600-km provide the most efficient convergence rate. If any problem arises from the convergence or overflow of numbers, the user is advised to try different L values. Most of the time this solves such problems. If it does not solve the problem, the best thing to do is to change the data set. For example, if you are inverting 0000 UTC data set, try the 0600 UTC data set instead. Our studies showed that the PV inversion technique is sensitive to the data set used.

The PV inversion domain and distribution of grid points match the output of the JCMM version of the LAM. Horizontally the domain consists of 61 (in the zonal direction) by 38 (in the meridional direction) grid points with basic spacing 108.9-km. Vertically the domain consists of 9 constant pressure levels from 900-mb to 100-mb. The convergence required takes about 15 minutes on a VAXSTATION 4000/90.

The author of this documentation combined the main NPVINVRE.FOR program with PREP_FILE.FOR program in order to save space and time. This version is named as MPVINVRE.FOR.

3 USING THE PROGRAMS FOR SIMPLE PV INVERSION

The operational MDIAG main program, MDIAG_LEVEL and MDIAG_SURFACE programs, were modified in order to provide input data for the PV inversion program and to use its outputs. Note also that they all work only for one time step. The PV inversion main program and associated programs are:

- MDIAG_BEFORE_PVINV.FOR: Calculates meteorological parameters. (See section 3.1)

New options added: Extract some data for the PV inversion. (PV modification option is also available see section 4.1)

- MPVINVRE.FOR: Inverts PV and provides geopotential height, temperature and wind data
- MDIAG_AFTER_PVINV.FOR: Calculates meteorological parameters.

New options added: Replace the PV inversion outputs with the original and calculate parameters from them, and also to extract a dataset for re-runs.

- MDIAG_LEVEL_PVINV.FOR: Generates a file for a pressure level
- MDIAG_SURFACE_PVINV.FOR: Interpolates parameters onto a PV or an isentropic surface.

The above listed programs are currently kept in the user2:[demirtas.lmdpvinv] directory. A list of programs and related files in that directory is given in the Appendix A. For details and latest changes see the system manager.

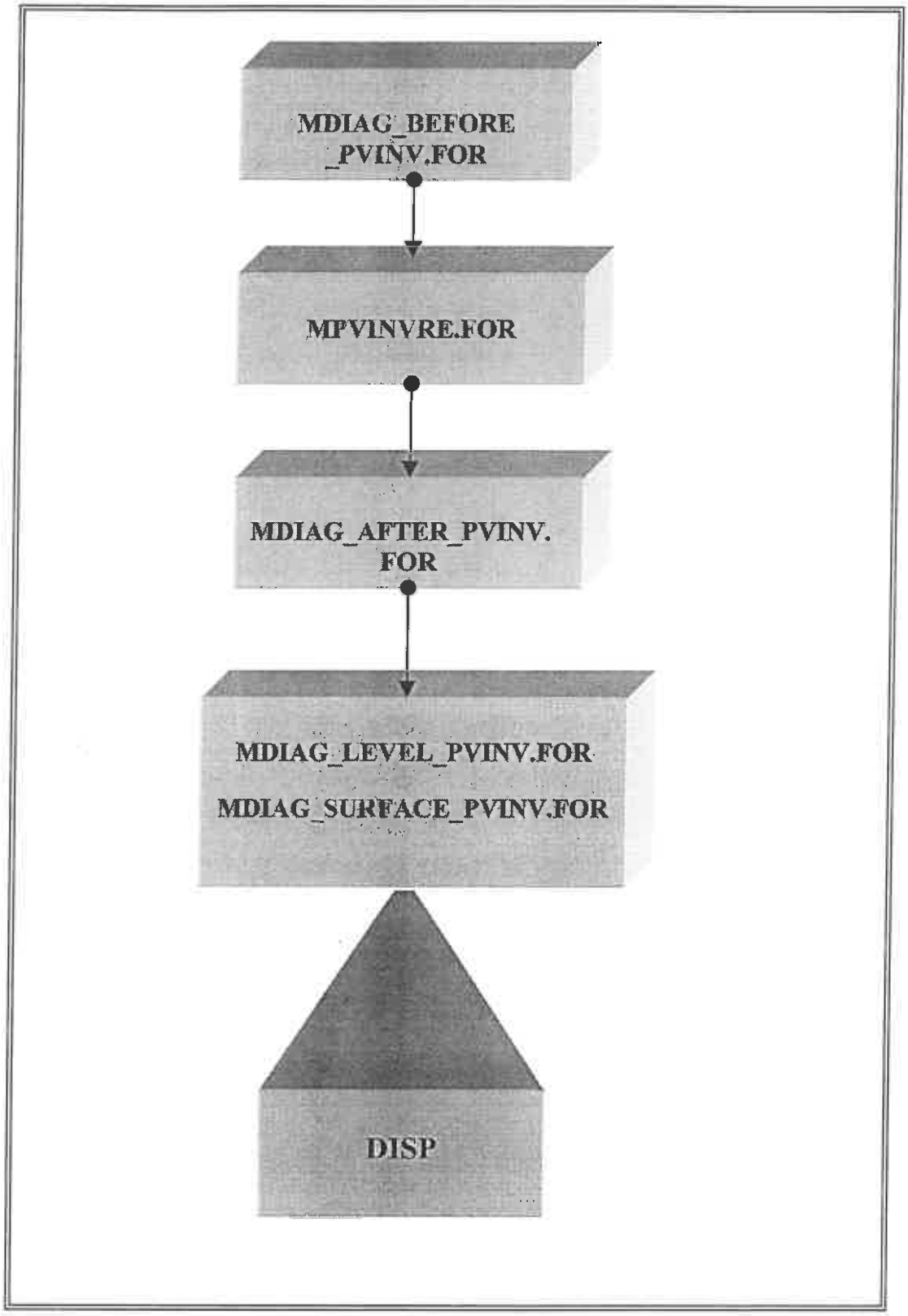

Figure (1): *A flow chart for the PV inversion related programs and the display system.*

The above programs can be run interactively, or by submitting a .com file as a batch job. In the following sections some explanations will be given how to edit the related .com files. You can also use one command file – called MDPVINV.COM - to run MDIAG_BEFORE_PVINV, MPVINVRE and MDIAG_AFTER_PVINV programs one after the other one. A copy MDPVINV.COM file is given in the Appendix B. You can edit that file and make your own runs.

3.1 MDIAG_BEFORE_PVINV.FOR

The aim of using this program is to provide geopotential height (PHI or sometimes named as FI), potential temperature (THETA), wind (u,v) and potential vorticity (PV) data for the PV inversion main program.

- ***MDIAG_BEFORE_PVINV.COM :*** Command procedures for running MDIAG_BEFORE_PVINV.FOR program.

Enter the path for MDIAG_BEFORE_PVINV.FOR program. For example:
RUN USER2:[DEMIRTAS.LMDPVINV] MDIAG_BEFORE_PVINV

Inputs required:

Line 1: Enter N to indicate that the automatic date files are not to be read. (This is because "Y" is used primarily for the automatic operational runs.)

Line 2: Enter the path for the MDIAG parameter list.
Example: USER2:[DEMIRTAS.LMDPVINV]MDIAG_PARAMS_FULL
"MDIAG_PARAMS_FULL.DEF" contains the standard parameters. (It is given in the Appendix C. Note that edited version can be made for fewer diagnostics.)

Line 3: Enter input path without the extension.
Example: USER2:[DEMIRTAS.CASE1]UA160295

[It reads UA160295.CAT and UA160295.DAT for UA160295.DB and UA160295.ATB outputs (see line 4). It also generates FI.DAT, THETA.DAT, UU.DAT, VV.DAT and PV.DAT files (see line 6) for the PV inversion program.]

Line 4: Enter the output path without the extension.
Example: USER2:[DEMIRTAS.CASE1]UA160295

Line 5: Enter a number for the time the PV inversion will be performed.
Examples: 1 for 0000 UTC, 3 for 0600 UTC, and 5 for 1200 UTC.

Line 6: Enter the output path for the FI, PTEMP, U, V and PV output files.
Example: USER2:[DEMIRTAS.CASE1]
** P.S. Path name should not be more than 24 characters. If it is bigger than this, you have to make changes in the main program.

Line 7: Type "N or n". PV changes are not going to take place at this stage. (For PV modification see sections 4 and 4.1.)

3.2 MAIN PV INVERSION PROGRAM: MPVINVRE.FOR

This program inverts PV and generates the FIinv, TEMPinv, UUinv, and VVinv datasets.

- ***MPVINVRE.COM***

Enter the path for the program without extension. For example:
RUN USER2:[DEMIRTAS.LMDPVINV]MPVINVRE

Inputs required:

Line 1: Enter number for iterations (NITS). The program will STOP when the convergence criteria are met. It may stop before the user defined NITS are completed.

Line 2: Enter a value for L (horizontal scale) which will be used for calculating COEF2=[(H/L)**2]. The L value can be taken between 100-1000-km.
Example: 300

Line 3: Enter "Y or y" if you want the program to run until the convergence "criteria" are satisfied. "N or n" will run the program until the user defined iteration limit.

Line 4,5,6,7,8: Enter the input path.

Example: USER2:[DEMIRTAS.CASE]FI1.DAT
USER2:[DEMIRTAS.CASE]THETA1.DAT
USER2:[DEMIRTAS.CASE]UU1.DAT
USER2:[DEMIRTAS.CASE]VV1.DAT
USER2:[DEMIRTAS.CASE]PV1.DAT

[Here 1 indicates 0000 UTC data. Note also that these are produced by the MDIAG_BEFORE_PVINV.FOR program.]

Line 9,10,11,12: Enter the output path.

Example: USER2:[DEMIRTAS.CASE]FIINV1.DAT
USER2:[DEMIRTAS.CASE]TEMPINV1.DAT
USER2:[DEMIRTAS.CASE]UUINV1.DAT
USER2:[DEMIRTAS.CASE]VVINV1.DAT

[Here 1 indicates 0000 UTC data.]

3.3 MDIAG_AFTER_PVINV.FOR

This program uses PV inversion outputs to generate other meteorological parameters. In other words, it uses PV inversion results of FIinv, TEMPinv, UUinv and VVinv and generates a .DB file and a .ATB file.

❖ *MDIAG_AFTER_PVINV.COM*

Enter the path for MDIAG_AFTER_PVINV.FOR program without extension. For example:
RUN USER2:[DEMIRTAS.LMDPVINV] MDIAG_AFTER_PVINV.FOR

Inputs required:

Line 1: Enter N to indicate that the automatic date files are not to be read.

Line 2: Enter the path for the parameter list.
Example: USER2:[DEMIRTAS.MDPVINV]MDIAG_PARAMS_FULL
[See Appendix C for details.]

Line 3: Enter input path without the extension.
Example: USER2:[DEMIRTAS.CASE1]UA160295
[Note that this is the original data set.]

Line 4: Enter the output path without the extension.
Example: USER2:[DEMIRTAS.CASE]ICASE
[Here "I" is used to indicate that this is PV inversion result.]

Line 5,6,7,8: Enter the input path and file names.
Example: USER2:[DEMIRTAS.CASE]FIINV1.DAT
USER2:[DEMIRTAS.CASE]TEMPINV1.DAT
USER2:[DEMIRTAS.CASE]UUINV1.DAT
USER2:[DEMIRTAS.CASE]VVINV1.DAT
[Here 1 indicates 0000 UTC data. Note that these are MPVINVRE.FOR program outputs.]

Line 9: Enter a number that corresponds with PV inversion time.
Examples: 1 for 0000 UTC, 3 for 0600 UTC, and 5 for 1200 UTC.

[Note that this has to be same as the one specified for MDIAG_BEFORE_PVINV.FOR program.]

Line 10: Type "Y or y" if you want to extract some data for re-runs. When you say "Y or y" be sure that you have defined related parameters and locations.

Line 11: Enter the output path and the file name.
Example: USER2:[DEMIRTAS.CASE1]C1.DAT
[This is the file that contains the data for re-runs. See section 4.3.]

4 USING THE PROGRAMS FOR PV MODIFICATIONS

The user should define the locations and magnitudes of PV values within the main program. The relevant section for this task has been shown with comment lines in the MDIAG_BEFORE_PVINV.FOR program. In that section the user needs to specify the following:
(1) horizontal locations with **(I,J grid points)**, (2) vertical location with a pressure level code (see table 1 for details), and (3) new PV values.

1. How to convert DISP x,y distances into the MDIAG **I,J** locations.

   I=(X_Distance/101.6)+1

   J=(Y_Distance/101.6)+1

Here 101.6-km is the DISP grid spacing. Since the origin starts with (0,0) in the DISP, you need to add 1 to get the same location in the MDIAG. Figure 2 presents the DISP LAM area and crosses show some PV modification points.

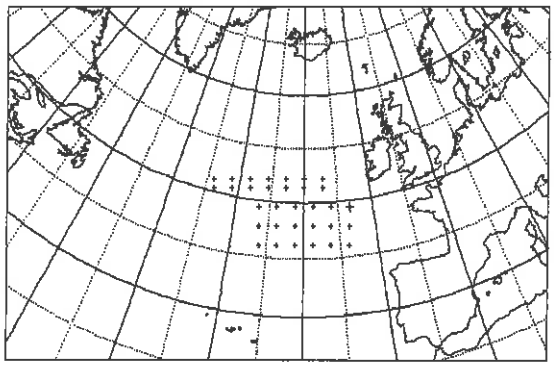

Figure (2): *LAM area in DISP and some locations of the data provided for a re-run.*

2. How the pressure levels are coded.

Main MDIAG program reads pressure levels in the following coding.

CODES	LEVELS (mb)
1	1000
2	900
3	800
4	700
5	600
6	500
7	400
8	300
9	200
10	100

Table (1): *Pressure levels and coding system in the MDIAG main program.*

3. How to choose new PV values.

This depends on the user's aims. If you want to modify PV distribution with respect to the Meteosat water vapour imagery, you may be interested to see the JCMM Internal Report 71 (Demirtaş and Thorpe 1997).

4.1 MDIAG_BEFORE_PVINV.FOR

This is the same as the program described in section (3.1). The aim here is to use it for altering the original PV distributions.

Points to note: If you are using MDIAG_BEFORE_PVINV for PV modifications, it is better to copy the program into another directory and re-arrange it in there. Otherwise, you may overwrite or get confused with other versions.

❖ ***MDIAG_BEFORE_PVINV.COM***

Enter the path for Mdiag1.for program. For example:
RUN USER2:[DEMIRTAS.CASE1.T1]MDIAG_BEFORE_PVINV

Inputs required:

Line 1: Enter N to indicate that the automatic date files are not to be read.
Line 2: Enter the path for the parameter list.
Example: USER2:[DEMIRTAS.LMDPVINV]MDIAG_PARAMS_FULL

Line 3: Enter input path without the extension.
Example: USER2:[DEMIRTAS.CASE1]UA160295

Line 4: Enter the output path without the extension.
Example: USER2:[DEMIRTAS.CASE1.T1]MD160295
[Note that "MD" is used here to indicate that this is a "modified dataset".]

Line 5: Enter a number that corresponds with PV inversion time.
Examples: 1 for 0000 UTC, 3 for 0600 UTC, and 5 for 1200 UTC.

Line 6: Enter the output path for the FI, PTEMP, U, V and PV.
Example: USER2:[DEMIRTAS.CASE1.T1]
** P.S. The path name should not be more than 24 characters. If it is bigger than this, you have to make changes in the main program.

Line 7: Type "Y or y" in order to direct the program to change original PV distribution.

4.2 MAIN PV INVERSION PROGRAM

This is the same as the one described in the section (3.2).

4.3 MDIAG_AFTER_PVINV.FOR

This is the same as the one described in the section (3.3). The only difference is that it provides additional datasets, based on the user defined PV modifications, for a re-run. In order to get these datasets, you should specify within the main program parameters that you need and locations (I,J grid points). The datasets have the following format.

Lat (°N)	Lon (°E)	Pressure (mb)	Temp (°C)	U(m/s)	V(m/s)

***Table (2):** Output data format.*

Points to note: If you are using the MDIAG_AFTER_PVINV for PV modifications, it is better to copy the program into another directory and re-arrange it in there. Otherwise, you may overwrite or get confused with other versions.

❖ *MDIAG_AFTER_PVINV.COM*

Enter the path for MDIAG_AFTER_PVINV.FOR program without extension. For example: RUN USER2:[DEMIRTAS. LMDPVINV]MDIAG_AFTER_PVINV

Inputs required:

Line 1: Enter N to indicate that the automatic date files are not to be read.

Line 2: Enter the path for the parameter list.
Example: USER2:[DEMIRTAS.LMDPVINV]MDIAG_PARAMS_FULL
Line 3: Enter input path without the extension.
Example: USER2:[DEMIRTAS.CASE1]UA160295

Line 4: Enter the output path without the extension.
Example: USER2:[DEMIRTAS.CASE1.T1]IM160295
[Note that here "T" is used to indicate that this is the PV inversion result.]

Line 5,6,7,8: Enter the input path and file names.
Example: USER2:[DEMIRTAS.CASE1.T1]FIINV1.DAT
USER2:[DEMIRTAS.CASE1.T1]TEMPINV1.DAT
USER2:[DEMIRTAS.CASE1.T1]UUINV1.DAT
USER2:[DEMIRTAS.CASE1.T1]VVINV1.DAT
[Here 1 represents 0000 UTC data time.]

Line 9: Enter a number that corresponds with PV inversion time.
Examples: 1 for 0000 UTC, 3 for 0600 UTC, and 5 for 1200 UTC.

Line 10: Type "Y or y" if you want to extract data for re-runs. When you say "Y or y" be sure that you have defined related parameters and locations.

Line 11: Enter the output path and the file name, if you typed "Y or y" in the previous line.
Example: USER2:[DEMIRTAS.CASE1.T1]MDC1.DAT
[Here "MD" is used to indicate that these data are obtained from the PV modifications.]

5 PROGRAMS FOR DISPLAYING RESULTS ON THE PRESSURE AND ISENTROPIC/PV SURFACES

The following sections explain MDIAG_LEVEL_PVINV and MDIAG_SURFACE_PVINV programs and their .com files. They are needed for preparing the data for DISP.

5.1 MDIAG_LEVEL_PVINV.FOR

This program extracts data on a pressure level. The main difference between this version and the standard one is that this one works only for a user defined time step that corresponds to PV inversion time.

❖ *MDIAG_LEVEL_PVINV.COM*

Enter the path name without extension. For example:
RUN USER2:[DEMIRTAS.LMDPVINV]MDIAG_LEVEL_PVINV

Inputs required:

Line 1: Enter N to indicate that the automatic date files are not to be read.
Line 2: Enter input path without the extension.
Example: USER2:[DEMIRTAS.CASE1]UA160295

Line 3: Enter the output path without the extension.
Example: USER5:[MERAL.CASES.CASE1]UA160295

[Note that these results should be put into a directory that can be seen by a PC. For details see the system manager.]

Line 4: Enter a number for pressure level (1,2,3,4,5,6,7,8,9,10)
E.g. 1 is for 100-mb, 10 is for 1000-mb

Line 5: Total number of parameters required.
E.g.: 4 (Say you want geopotential height, u,v and PV, then the total is 4)

Line 6+n: Parameter numbers
Examples: 1 (for geopotential height)
3 (for u)
4 (for v)
16 (for PV)
[See also Appendix C for the parameter list.]

5.2MDIAG_SURFACE_PVINV.FOR

This interpolates parameters onto a surface. The main difference between this version and the standard one is that this one works only for a user defined time step that corresponds to PV inversion time.

❖ *MDIAG_SURFACE_PVINV.COM*

Enter the path name without extension. For example:
RUN USER2:[DEMIRTAS.LMDPVINV]MDIAG_SURFACE_PVINV

Inputs required:

Line 1: Enter N to indicate that the automatic date files are not to be read.
Line 2: Enter input path without the extension.

Example: USER2:[DEMIRTAS.CASE1]UA160295

Line 3: Enter the output path without the extension.

Example: USER5:[MERAL.CASES.CASE1]UA160295

[Note that these results are put into the "cases" directory in order to be retrieved by a PC!]

Line 4: Parameter for choice of a surface.

E.g. 6 for an isentropic, 16 for an iso-PV surface.

Line 5: Value for that parameter.

E.g. 42 for 315K isentropic surface, 2 for PV=2 iso-PV surface.

Line 6: Title for the surface chosen.

E.g. 315K for the isentropic surface, PV=2 for the PV=2 iso-PV surface.

Line 7: Total number of parameters required.

E.g.: 4 (Say you want geopotential height, u,v and PV)

Line 8+n: Parameter numbers

Examples: 1 (for geopotential height)
3 (for u)
4 (for v)
16 (for PV)

[See also Appendix C for the parameter list.]

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APPENDICES

A LIST OF PROGRAMS AND RELATED FILES IN DIRECTORY USER2:[DEMIRTAS.LMDPVINV]

```
CONVRT.FOR;29                9  25-APR-1995 15:54:30.47  (RWED,RWED,RE,)
CORIOLIS.DAT;1              73  16-AUG-1994 10:55:55.34  (RWED,RWED,RE,)
DEX.DAT;1                    1  19-SEP-1994 08:33:53.29  (RWED,RWED,RE,)
MAPFAC.DAT;1                73  16-AUG-1994 10:55:56.99  (RWED,RWED,RE,)
MDIAG.LIS;1                  6  24-OCT-1997 10:11:53.01  (RWED,RWED,RE,)
MDIAG_AFTER_PVINV.COM;3
                             5  19-DEC-1997 10:10:07.71  (RWED,RWED,RE,)
MDIAG_AFTER_PVINV.EXE;3
                           240   7-NOV-1997 10:18:07.01  (RWED,RWED,RE,)
MDIAG_AFTER_PVINV.FOR;6
                            88  19-DEC-1997 09:55:09.38  (RWED,RWED,RE,)
MDIAG_AFTER_PVINV.OBJ;3
                            54   7-NOV-1997 10:17:52.09  (RWED,RWED,RE,)
MDIAG_BEFORE_PVINV.COM;3
                             4  19-DEC-1997 09:52:19.50  (RWED,RWED,RE,)
MDIAG_BEFORE_PVINV.EXE;1
                           233  15-OCT-1997 11:42:31.77  (RWED,RWED,RE,)
MDIAG_BEFORE_PVINV.FOR;5
                            76  19-DEC-1997 09:50:01.08  (RWED,RWED,RE,)
MDIAG_BEFORE_PVINV.OBJ;1
                            45  15-OCT-1997 11:41:52.93  (RWED,RWED,RE,)
MDIAG_LEVEL_PVINV.COM;64
                             4  12-NOV-1997 12:48:59.81  (RWED,RWED,RE,)
MDIAG_LEVEL_PVINV.EXE;12
                            23  16-OCT-1997 13:17:43.56  (RWED,RWED,RE,)
MDIAG_LEVEL_PVINV.FOR;9
                            24  16-OCT-1997 13:17:15.95  (RWED,RWED,RE,)
MDIAG_LEVEL_PVINV.OBJ;10
                            15  16-OCT-1997 13:17:36.60  (RWED,RWED,RE,)
MDIAG_PARAMS.DEF;3           4  24-OCT-1997 10:22:38.19  (RWED,RWED,RE,)
MDIAG_PARAMS.FULL;8
                             3  31-MAR-1996 16:36:49.87  (RWED,RWED,RE,)
MDIAG_SURFACE_PVINV.COM;21
                             4  10-NOV-1997 14:59:10.81  (RWED,RWED,RE,)
MDIAG_SURFACE_PVINV.EXE;26
                            27  16-OCT-1997 14:10:26.26  (RWED,RWED,RE,)
MDIAG_SURFACE_PVINV.FOR;22
                            31  16-OCT-1997 14:10:14.98  (RWED,RWED,RE,)
MDIAG_SURFACE_PVINV.OBJ;26
                            19  16-OCT-1997 14:10:20.14  (RWED,RWED,RE,)
MDPVINV.COM;12              17  19-DEC-1997 10:14:11.17  (RWED,RWED,RE,)
MPACK.OBJ;1                  4  15-OCT-1997 13:27:32.83  (RWED,RWED,RE,)
NPVINVRE.COM;40              5  12-SEP-1997 16:13:20.45  (RWED,RWED,RE,)
NPVINVRE.EXE;16             57  11-SEP-1997 14:20:51.47  (RWED,RWED,RE,)
NPVINVRE.FOR;27            110  11-SEP-1997 14:20:34.01  (RWED,RWED,RE,)
NPVINVRE.OBJ;20             45  11-SEP-1997 14:20:37.48  (RWED,RWED,RE,)
P_FORM.OBJ;2                 8  15-OCT-1997 13:27:29.98  (RWED,RWED,RE,)
TMP.LIS;1                    0  19-DEC-1997 10:15:05.29  (RWED,RWED,RE,)
Total of 31 files, 1307 blocks.
```

B. MDPVINVRE.COM

```
$! MDPVINVRE.COM
$! ==============
$!
$! Command procedures to invert PV and create display files.
$!
$! There are mainly 3 programs that have to be run for this purpose. The
$! following documentation was prepared to help users how to run each
$! program. (Meral Demirtas, 12 September 1997)
$!
$!=============================================================================
$! I. LINES FOR MDIAG1.FOR (It is for getting data for PV inversion.)
$!          New Name: MDIAG_BEFORE_PVINV
$!=============================================================================
$!
$!  Run MDIAG1. This provides FI, TEMP, WIND, and PV data for inversion
$!              and generates 2 files (.DB and .ATB).
$!              The program can also be used modifying PV distribution.
$!
$!       [*** Please note that this MDIAG version is different than the
$!            others. It is run only for one time step! ***]
$!
$!     line 1 :Y if reading filename from MDATE.DAT, N if not. Usually
$!             only the routine daily run reads from FMDATE.DAT so use N
$!
$!     line 2 : Enter the path for the parameter list. Usually
$!              MDIAG_PARAMS.DEF for the standard parameters.
$!
$!     line 3 : If reading from MDATE.DAT enter input dataset directory.
$!              If not reading from MDATE.DAT enter input path without
$!              the extension e.g. USER2:[FMOUTPUT]FMSTORMA
$!
$!     line 4 : If reading from MDATE.DAT enter output directory name.
$!              If not reading from MDATE.DAT enter output path without
$!              the extension e.g. USER2:[FMOUTPUT]FMSTORMA
$!
$!     line 5: Enter a number for PV inversion data time.
$!             e.g. 3 for 0600 UTC. (1 for 0000 UTC, 5 for 1200 UTC)
$!
$!     line 6: Enter output dataset directory for the inversion.
$!             e.g. user7:[demirtas.11dec_case]
$!      ** P.S. Directory name should not be more than 24 characters.
$!
$!     line 7: If you want to make PV modifications type "Y or y".
$!
$! ----------------------------------------------------------------------------
$!
$! An example:
$!
$! RUN USER2:[demirtas.Lmdpvinv]MDIAG_BEFORE_PVINV
$! N
$! USER2:[demirtas.lmdpvinv]MDIAG_PARAMS.FULL
$! USER2:[demirtas.iop12]ua080297
$! USER2:[demirtas.fc1]rfc1
$! 1
$! user2:[demirtas.fc1]
$! Y
$!
```

```
$!=====================================================================
$! II.  LINES FOR PVINVERSION PROGRAM: NPVINVRE.FOR
$!=====================================================================
$!
$!    NPVINVRE.FOR inverts PV and generates FIinv, TEMPinv, UUinv, VVinv
$!    data set to be used in the other MDIAG.FOR program.
$!
$! Line 8. Enter number for iterations will be used in the program.
$! There is also test procedure that stops the program before reaching
$! NITS value. e.g. NITS=500 but the program may finish when NITS=150
$!
$! Line 9. Enter a value for L which will be used in COEF2=[(H/L)**2].
$! This is the coefficient varies between 0.001 to 0.0003 depending on
$!         the case study. [H=10km.]
$!
$! Line 10. Enter `Y'if the program is wanted to stop according to
$! test criteria. `N' or `n' will run the program until a user defined
$! iterations ends.
$!
$! Lines 11,12,13,14,15. Enter input file names for FI,U,V,PV and THETA.
$!
$!            e.g. user7:[demirtas.case1]FI3.DAT
$!                 user7:[demirtas.case1]UU3.DAT
$!                 user7:[demirtas.case1]VV3.DAT
$!                 user7:[demirtas.case1]PV3.DAT
$!                 user7:[demirtas.case1]TH3.DAT
$!
$! (Here 3 represents 00600 UTC data time.)
$!  e.g. 1 is for 0000 UTC, 5 is for 1200 UTC.
$!
$! Lines 16,17,18,19:
$!                      Enter output directory and file
$!                      names for U,V,FI,temperature:
$!
$!                   e.g.  user7:[demirtas.md]fiinv.dat
$!                         user7:[demirtas.md]tempinv.dat
$!                         user7:[demirtas.md]uinv.dat
$!                         user7:[demirtas.md]vinv.dat
$!---------------------------------------------------------------------
$! An example:
$!
$! RUN USER2:[demirtas.lmdpvinv]NPVINVRE
$! 500
$! 400
$! y
$! user2:[demirtas.fc1]fi1.dat
$! user2:[demirtas.fc1]uu1.dat
$! user2:[demirtas.fc1]vv1.dat
$! user2:[demirtas.fc1]pv1.dat
$! user2:[demirtas.fc1]th1.dat
$! user2:[demirtas.sil]fiinv1.dat
$! user2:[demirtas.sil]tempinv1.dat
$! user2:[demirtas.sil]uuinv1.dat
$! user2:[demirtas.sil]vvinv1.dat
```

```
$!=================================================================
$!III. LINES FOR MDIAG2.FOR (It is for using data for PV inversion data)
$!         New Name: MDIAG_AFTER_PVINV
$!=================================================================
$!
$!     Run MDIAG2. uses FIinv, TEMPinv, UUinv and VVinv data
$!                    and generates 2 files (.DB and .ATB).
$!                    The program can also provide data for re-runs.
$!
$!        [*** Please note that this MDIAG version is different than the
$!                  others. It is run only for one time step! ***]
$!
$!     line 20 :Y if reading filename from MDATE.DAT, N if not. Usually
$!              only the routine daily run reads from FMDATE.DAT so use N
$!
$!     line 21 : Enter the path for the parameter list. Usually
$!               MDIAG_PARAMS.DEF for the standard parameters.
$!
$!     line 22 : If reading from MDATE.DAT enter input dataset directory.
$!               If not reading from MDATE.DAT enter input path without
$!               the extension e.g. USER2:[FMOUTPUT]FMSTORMA
$!
$!     line 23 : If reading from MDATE.DAT enter output directory name.
$!               If not reading from MDATE.DAT enter output path without
$!               the extension e.g. USER2:[FMOUTPUT]FMSTORMA
$!
$!     lines 24,25,26,27: Enter the input dataset directory names
$!                        of FI,temp,U,V
$!
$!                   e.g. user7:[demirtas.md]FI1.dat
$!                        user7:[demirtas.md]uu1.dat
$!                        user7:[demirtas.md]vv1.dat
$!                        user7:[demirtas.md]th1.dat
$!
$!     line 28: Enter a number that corresponds with PV inversion time.
$!              e.g. 3 for 0600 UTC. (1 for 0000 UTC, 5 for 1200 UTC)
$!
$!     line 29: If you want to get data for re-runs type "Y or y".
$!
$!     line 30: Enter a file name for a re-run dataset.
$!               e.g. user2:[demirtas.case1]Case1.dat
$!
=================================================================
$! An example:
$!
$! RUN USER2:[demirtas.Lmdpvinv]MDIAG_AFTER_PVINV
$! N
$! USER2:[demirtas.lmdpvinv]MDIAG_PARAMS.FULL
$! USER2:[demirtas.iop10]ua080297
$! USER2:[demirtas.case1]ic1t2
$! user2:[demirtas.case1]fiinv1.dat
$! user2:[demirtas.case1]tempinv1.dat
$! user2:[demirtas.case1]uuinv1.dat
$! user2:[demirtas.case1]vvinv1.dat
$! 1
$! y
$! user2:[demirtas.case1]case1.dat
```

```
$!=====================================================================
$ RUN USER2:[demirtas.lmdpvinv]MDIAG_BEFORE_PVINV
N
USER2:[demirtas.lmdpvinv]MDIAG_PARAMS.FULL
USER2:[demirtas.iop10]ua030297
USER2:[demirtas.lmdpvinv]msil1
5
user2:[demirtas.lmdpvinv]
Y
$!
$! optional! If you do not wand the following files then remove ! sign.
$! So that the system automatically will delete them.
$!
$! DELETE /NOCONFIRM [demirtas.case1]test.ATB;*
$! DELETE /NOCONFIRM [demirtas.case1]test.DB;*
$!
$ RUN USER2:[demirtas.lmdpvinv]NPVINVRE
500
400
Y
user2:[demirtas.lmdpvinv]fi5.dat
user2:[demirtas.lmdpvinv]uu5.dat
user2:[demirtas.lmdpvinv]vv5.dat
user2:[demirtas.lmdpvinv]th5.dat
user2:[demirtas.lmdpvinv]pv5.dat
user2:[demirtas.lmdpvinv]fiinv5.dat
user2:[demirtas.lmdpvinv]tempinv5.dat
user2:[demirtas.lmdpvinv]uuinv5.dat
user2:[demirtas.lmdpvinv]vvinv5.dat
$ RUN USER2:[demirtas.lmdpvinv]MDIAG_AFTER_PVINV
N
USER2:[demirtas.lmdpvinv]MDIAG_PARAMS.FULL
USER2:[demirtas.iop10]ua030297
USER2:[demirtas.mdpvinv]msil2
user2:[demirtas.mdpvinv]fiinv5.dat
user2:[demirtas.mdpvinv]tempinv5.dat
user2:[demirtas.mdpvinv]uuinv5.dat
user2:[demirtas.mdpvinv]vvinv5.dat
5
Y
user2:[demirtas.lmdpvinv]mdsil.dat
$!
$ exit
```

C MDIAG_PARAMS_FULL.DEF

```
================================================================================
The first 5 lines are comments. Then index numbers are read in
(FORMAT I2).
* When 99 is reached no more data is read in.
*================================================================================
 1  Geopotential height
 2  Temperature
 3  U component
 4  V component
 5  Relative Humidity(ice)
 6  Potential Temperature
 7  Equivalent potential temperature
 9  Humidity mixing ratio
10  Sat Equ Pot Temp
11  du/dp
12  dv/dp
13  d@/dp
14  d@e/dp
15  div V
16  Dry PV
17  Moist PV
18  Geostrophic U
19  Geostrophic V
20  Wind strength
21  Q1
22  Q2
23  div Q
24  Absolute vorticity
25  Vertical velocity
26  dv/dz-dvg/dz
27  du/dz-dug/dz
28  dug/dp
29  dvg/dp
30  Momentum
31  Magnitude geostrophic deformation
32  EW cpt, Gedef axis
33  NS cpt, Gedef axis
34  Mag Grad(ThetaE)
35  EW cpt, Grad(ThW)
36  NS cpt, Grad(ThW)
37  Geo Defmn wrt ThW
38  Relative vorticity
39  Geostrophic relative vorticity
40  Wind direction
41  Theta-W
42  U ageostrophic
43  V ageostrophic
44  Mag Grad(Th)
45  EW component, Grad(Th)
46  NS component, Grad(Th)
47  Q1 tangtl to Theta
48  Q2 tangtl to Theta
49  Div (Q tgtl)
50  Q1 normal to Theta
```

```
51  Q2 normal to Theta
52  Div (Q nrml)
53  Relative Humidity(wat)
54  Inv diab forcing
55  Inv divQ & diab
56  Inv-lap of divQ
57  Invlap divQ scaled
58  800-600mb Inv divQ
59  600-100mb Inv divQ
60  1000-800mb InvdivQ
61  Frontal Zones (ThW)
62  Front -^DelSqd(ThW)
63  Front -DelSqd(ThW)
64  Front |grad(ThW)|
65  Front Speed km/3hr
66  ThW-advection *1E4
67  Geost ThW-advn *1E4
68  Frontal Zones (Th)
69  Front -^delsqd(Th)
70  Front -delsqd(Th)
71  Front |grad(Th)|
72  Frnt Spd(Th)km/3hr
73  Th-advection *1e4
74  Geost Th-advn *1e4
75  Shear Rel Vort x1E5
76  Jet Stream "angle"
99  NO MORE PARAMETERS
*-------------------------------------------------------------------------
```

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